

# Main Cropping System Experiment (MCSE)

## Treatment Key

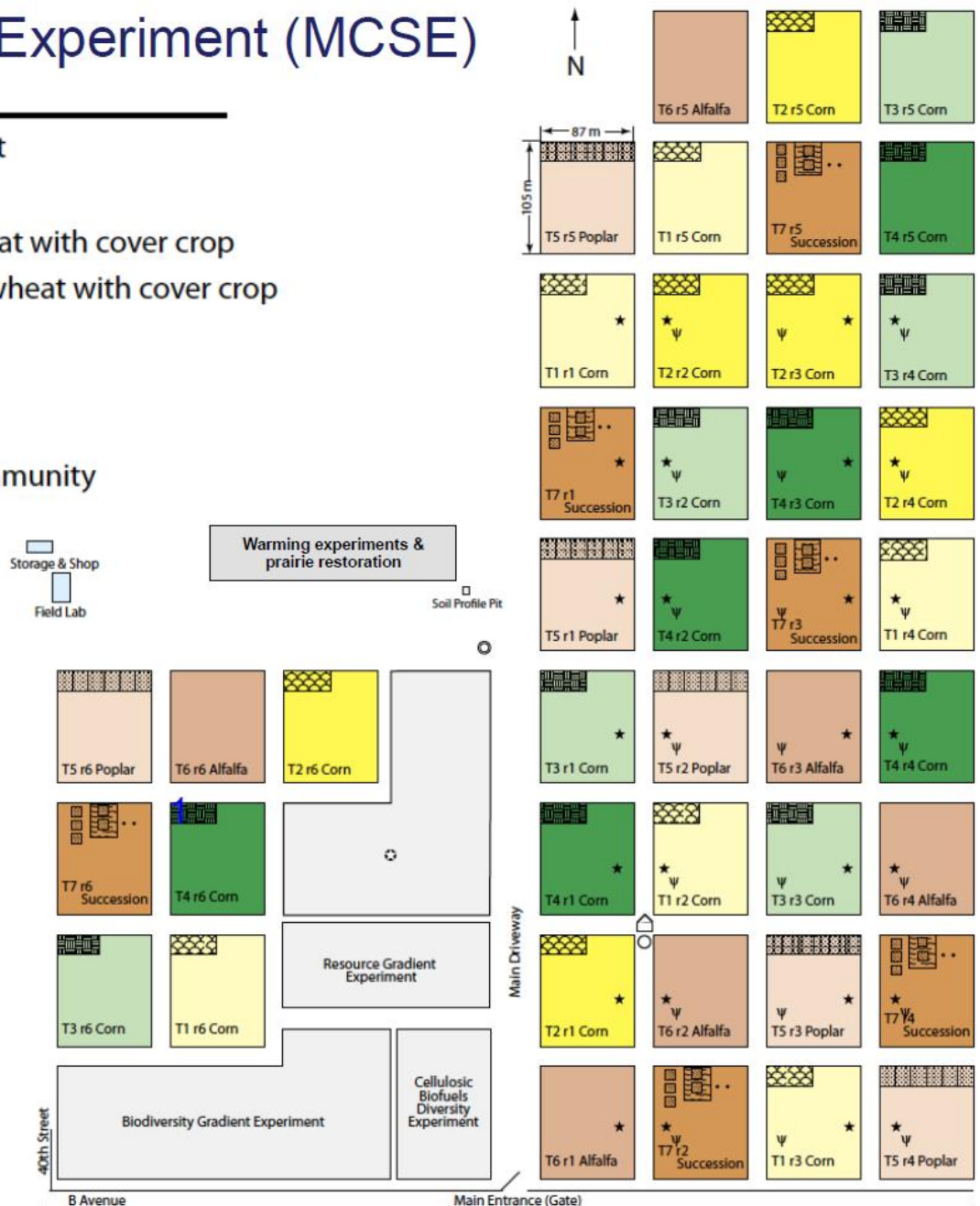
- T1 Conventional **corn**/soybean/wheat
  - T2 No-till **corn**/soybean/wheat
  - T3 Reduced Input **corn**/soybean/wheat with cover crop
  - T4 Biologically Based **corn**/soybean/wheat with cover crop
  - T5 Poplar
  - T6 Alfalfa
  - T7 Early Successional community
  - T8 Mown Grassland (never tilled) community
- r = replicate number

## Microplot Treatment Key

- Nitrogen fertilized
- Tillage (T7)
- Herbicide-free
- Nitrogen fertilized and weed-free

## Instrumentation Key

- Minirhizotrons
- ★ Trace gas flux chambers
- Ψ Low tension suction lysimeters
- ⊗ Weather station & weighing lysimeter
- ⌂ Trace gas shed
- Wireless tower & sun photometer
- ⊙ Aphid tower



# Experimental methods for investigating how climate change will affect...

## Meredith Zettlemoyer

1. Prairie restoration success and plant local adaptation.



Jen Lau, Lars Brudvig, Emily Grman

2. Plant-herbivore interactions.



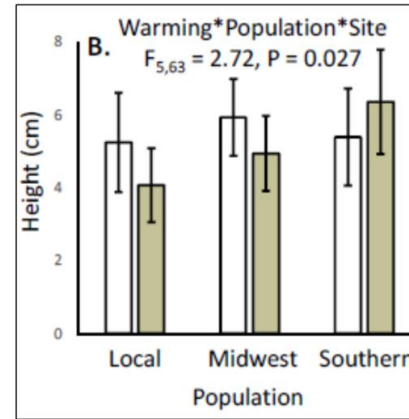
Phoebe Zarnetske, Kileigh Welshofer

3. Demography and phenology of native, exotic, & invasive species.

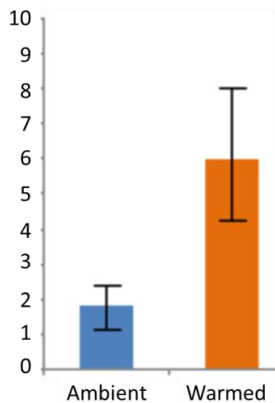


Meredith Zettlemoyer, Jen Lau

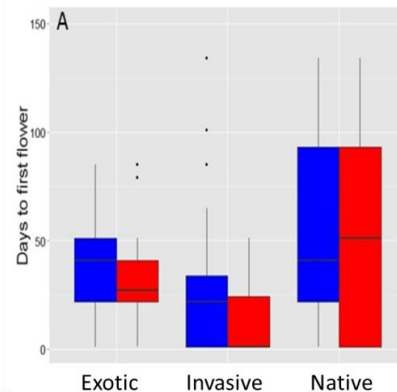
Warming increased growth of southern ecotypes, but reduced growth of local and Midwestern ecotypes



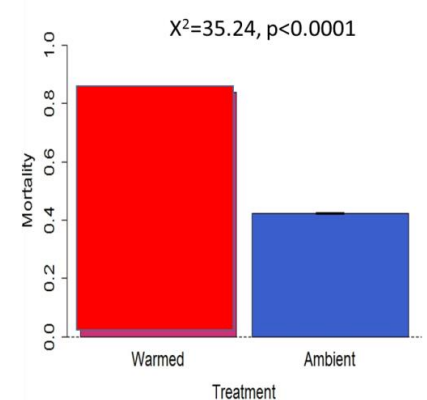
Plants grown in warmer conditions were more susceptible to slug herbivory



Invasive species dramatically advanced flowering in response to warming; native and exotic species did not



Warming increases mortality of both locally extinct and extant congeners

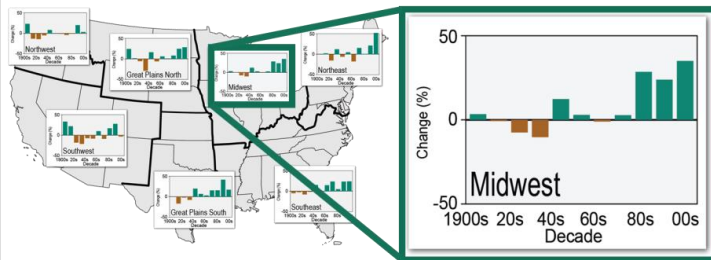


# Consequences of Changing Rainfall Patterns on Nitrous Oxide Fluxes in Cropping Systems

Kate Glanville

## Extreme Precipitation Events are Increasing

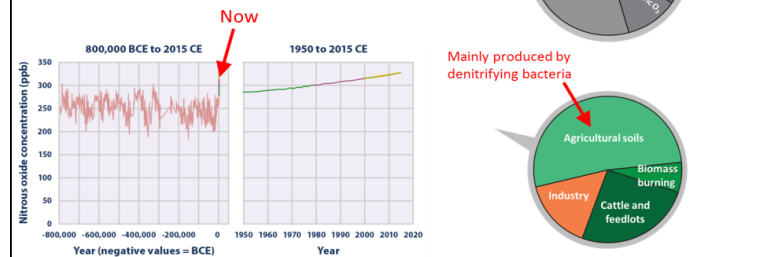
- Changes U.S. decadal precipitation falling in heaviest 1%:



Melillo et al. 2014

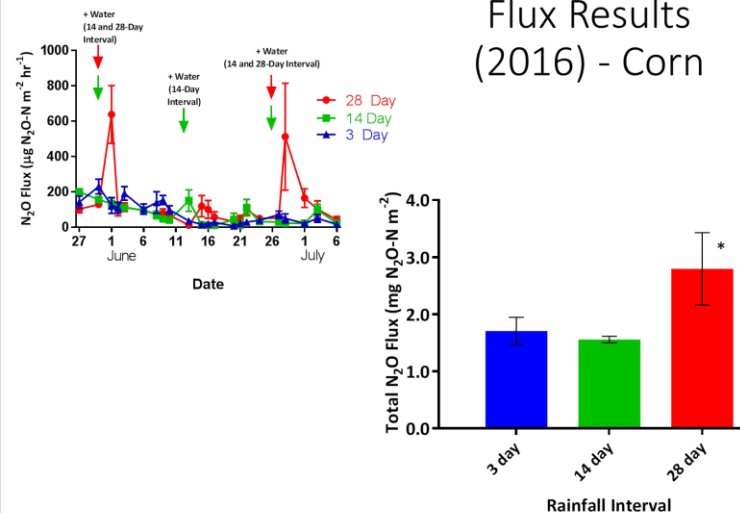
## Importance of N<sub>2</sub>O

- Dominant ozone-consuming substance in the stratosphere
- Strong greenhouse gas
- Increasing in atmosphere
- Agriculture is the dominant global source



Ravishankara et al. 2009; Redrawn from Robertson 2014; EPA 2016

## Flux Results (2016) - Corn



## Future Work

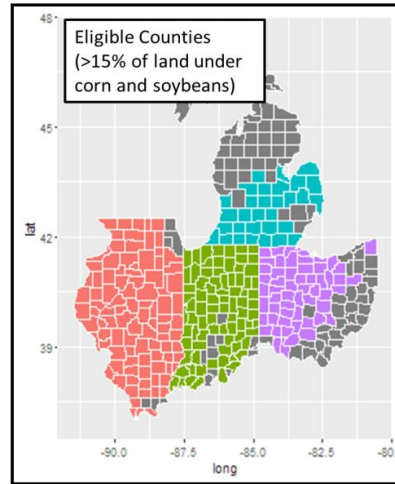
- Further analyses now underway to
  - understand the role of carbon and nitrogen resources
  - allocate source of N<sub>2</sub>O to denitrifiers and nitrifiers
  - how the differences in soil moisture influence fluxes

# The CMSP Farmer Survey and the MCSE: Initial findings and future directions

## Braeden Van Deynze & Sandy Marquart-Pyatt

### Survey Design

- Goal: long-term, representative panel of Eastern Corn Belt corn farmers (MI, IN, IL, OH)
- Mail questionnaire sent to 10k+ farmers in Feb 2017
- Topics: information, attitudes, incentives, resources, and management choices at the farm level and of one field planted with corn in 2016
- 3k returned surveys



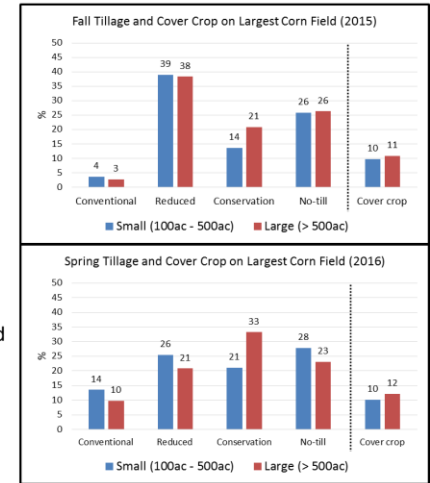
### Results: Tillage and Cover Crops

#### Percent of respondents who used \_\_\_\_\_ on their largest corn field...

*Conventional:* < 15% residue remaining  
*Reduced:* 15-30% residue remaining  
*Conservation:* > 30% residue remaining

#### Implications

- When farmers till in fall, conventional (e.g. moldboard) rarely used
- Larger operations more likely to use conservation tillage (e.g. vertical, ridge, strip) in both fall and spring
  - Likely due to equipment
- Cover cropping still rare
  - But 30% report planting at least sometimes, with about 10% doing so regularly



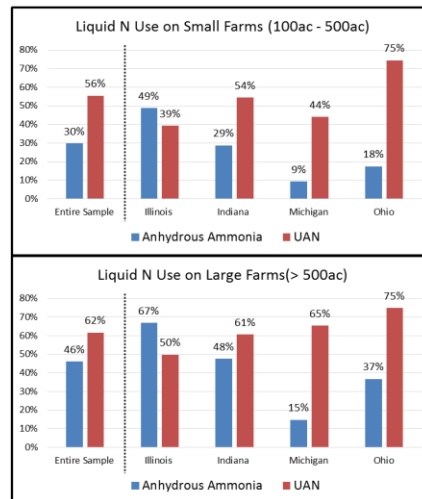
### Results: Use of Nitrogen Fertilizer

#### Percent of respondents who used \_\_\_\_\_ on their largest corn field...

*Note:* Percentages may not add to 100% due to multiple applications and other unreported N sources

#### Implications

- Small farms less likely to use anhydrous ammonia
- In Michigan, large farms far more likely to use UAN
- In Illinois, anhydrous ammonia used on more farms than UAN
  - Not so in other states
  - Why? Weather, geography? Social reasons?



### Future Work: Specific and Broader Questions

- Toward long-term socioecological research
- Given changing on-farm practice adoption, how do KBS LTER MSCE & GLBRC experimental treatments and farmer agronomic practices continue to inform one another?
- How do climate change and land use change shape farmers' knowledge, attitudes, and practice adoption?
- Moving from understanding to prediction
  - Panel data, surveys, interviews

# I want to know - have you ever seen the rain fungi?

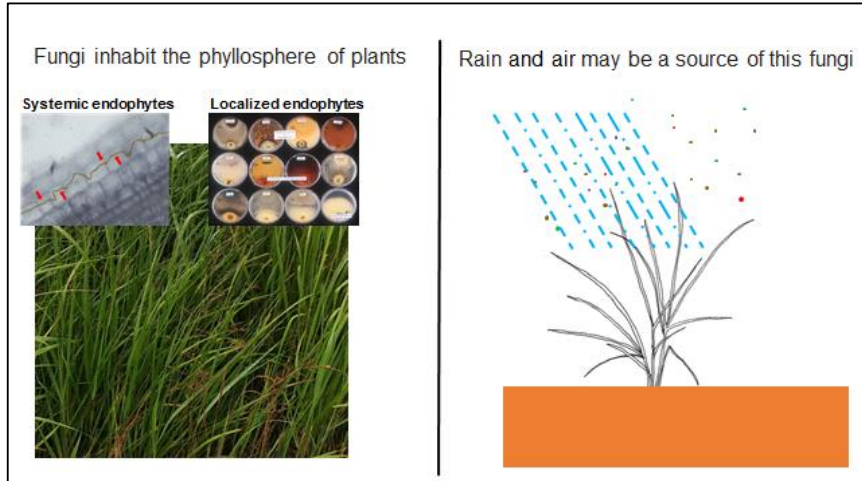
Lukas Bell-Dereske

Fungi inhabit the phyllosphere of plants

Rain and air may be a source of this fungi

Systemic endophytes

Localized endophytes



The diagram illustrates the concept of fungi in the phyllosphere. On the left, a photograph of green grass is shown with two inset images: 'Systemic endophytes' (a microscopic view of fungal hyphae) and 'Localized endophytes' (a petri dish with various fungal cultures). On the right, a schematic shows blue dashed lines representing rain falling on a plant, with small colored dots representing fungal spores in the air above it. An orange bar at the bottom represents the soil.

Methods

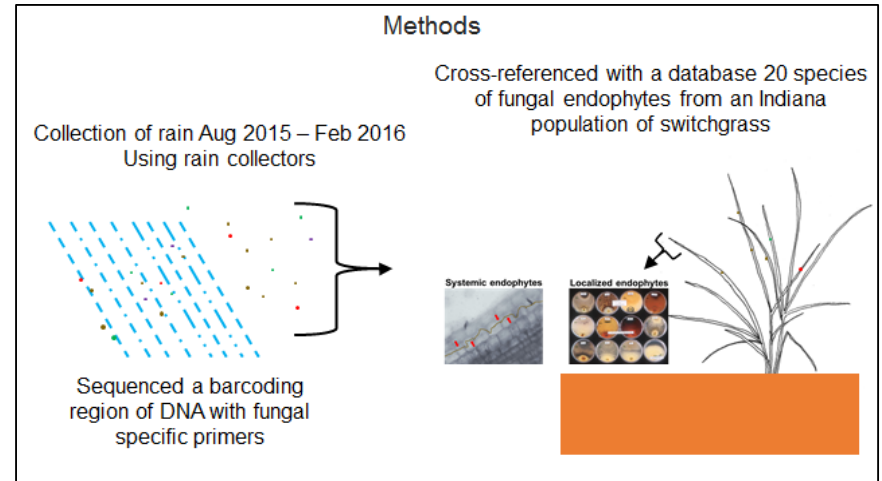
Cross-referenced with a database 20 species of fungal endophytes from an Indiana population of switchgrass

Collection of rain Aug 2015 – Feb 2016  
Using rain collectors

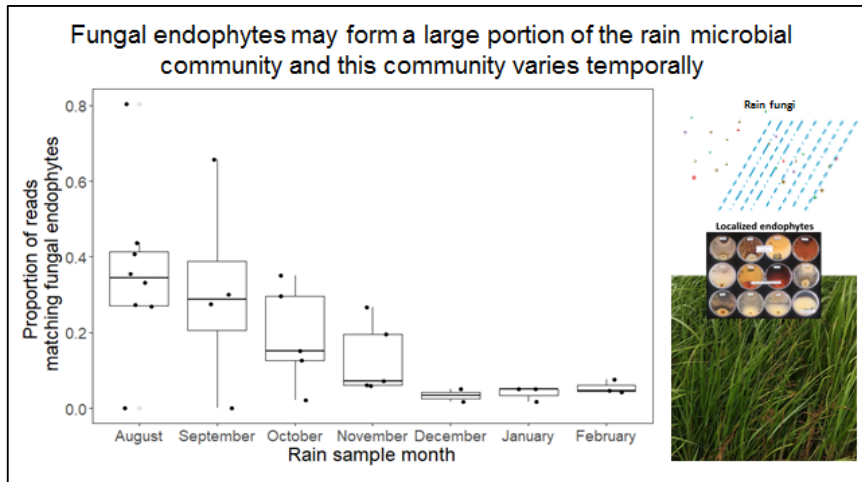
Sequenced a barcoding region of DNA with fungal specific primers

Systemic endophytes

Localized endophytes



The 'Methods' section details the experimental workflow. It shows a schematic of rain collection (blue dashed lines) and a bracket indicating that the collected rain is used for DNA sequencing. To the right, a plant is shown with arrows pointing to 'Systemic endophytes' and 'Localized endophytes' (represented by a petri dish), indicating that the rain samples are cross-referenced with a database of 20 species from an Indiana switchgrass population.



Future and ongoing work

Direct comparison of rain community to switchgrass phyllospheres

Shade lab GLBRC sampling 2016-2017 growing seasons

Sequencing switchgrass phyllosphere

Sequencing switchgrass soil

Collection of rain paired with Shade lab sampling June 2017 - ongoing

Measure the growth response of switchgrass to rain communities throughout the growing season

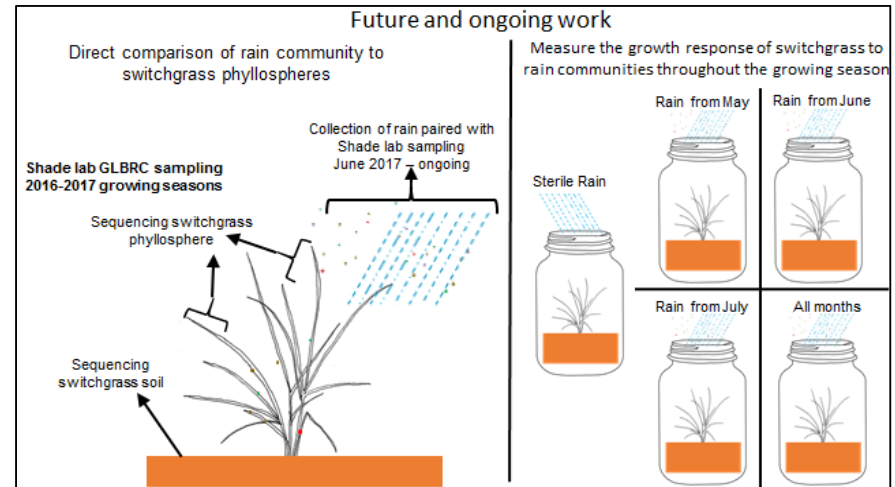
Rain from May

Rain from June

Rain from July

All months

Sterile Rain

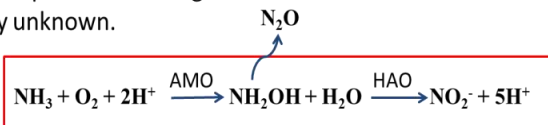


The 'Future and ongoing work' section outlines several experimental goals. It includes a diagram of a plant with arrows pointing to 'Sequencing switchgrass phyllosphere' and 'Sequencing switchgrass soil'. A bracket indicates 'Collection of rain paired with Shade lab sampling June 2017 - ongoing'. To the right, a 2x2 grid of jars shows 'Sterile Rain' and 'Rain from May', 'Rain from June', and 'Rain from July' treatments, with a fourth jar labeled 'All months'. The text indicates the goal is to 'Measure the growth response of switchgrass to rain communities throughout the growing season'.

# Management intensities and seasons affect the relative contribution of ammonia oxidizing bacteria (AOB) and ammonia oxidizing archaea (AOA) to nitrification

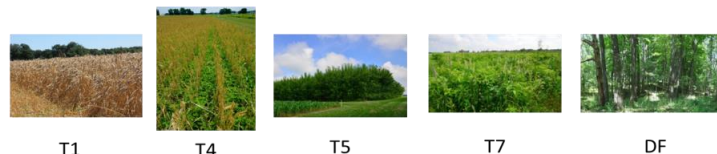
Di Liang

- Nitrification, mainly mediated by AOA and AOB, converts ammonia to nitrite.
- Nitrous oxide (N<sub>2</sub>O) is emitted into the atmosphere as a byproduct.
- Relative importance and significance of AOA vs. AOB in nitrification in soil is largely unknown.



## Seven ecosystems along a management gradient:

- T1: conventionally managed corn-soybean-wheat rotation
- T4: biologically managed corn-soybean-wheat rotation
- T5: poplar
- T7: early succession
- Fertilized T7: fertilized early succession
- DF: late successional deciduous forest
- Fertilized DF: fertilized late successional deciduous forest



T1

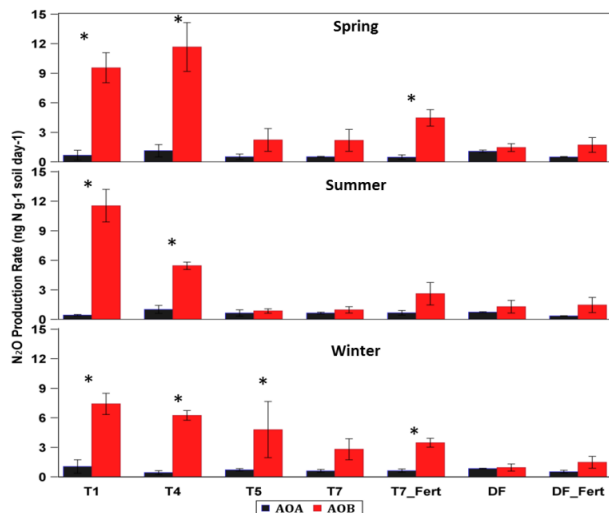
T4

T5

T7

DF

## Seasonal contribution of AOA and AOB to N<sub>2</sub>O



T1: Conventional Wheat

T4: Biologically Based Wheat

T5: Poplar

T7: Early Succession

T7\_Fert: Fertilized Early Succession

DF: Deciduous Forest

DF\_Fert: Fertilized Deciduous Forest

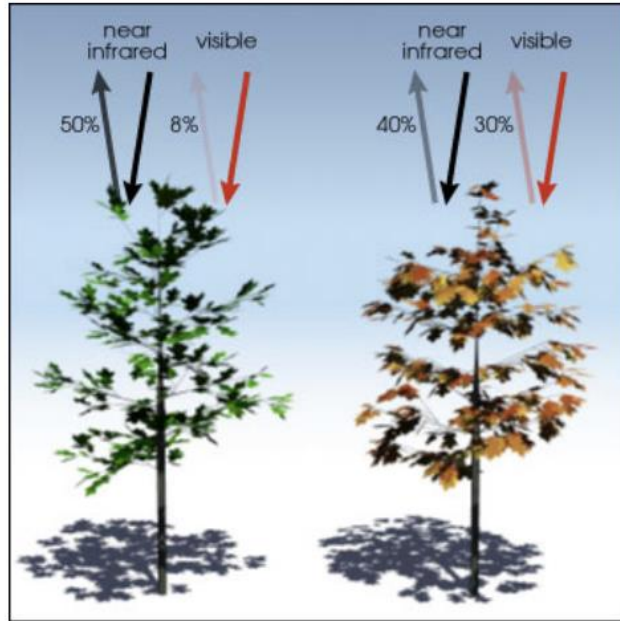
## Future Work

- What is the relative contribution of nitrification in N<sub>2</sub>O emission compared to other biological processes?
- The importance and mechanisms of AOA and AOB in nitrifier denitrification.



# Remote sensing of vegetation

**Normalized Difference Vegetation Index (NDVI) is a measure of plant canopy cover and vigor**



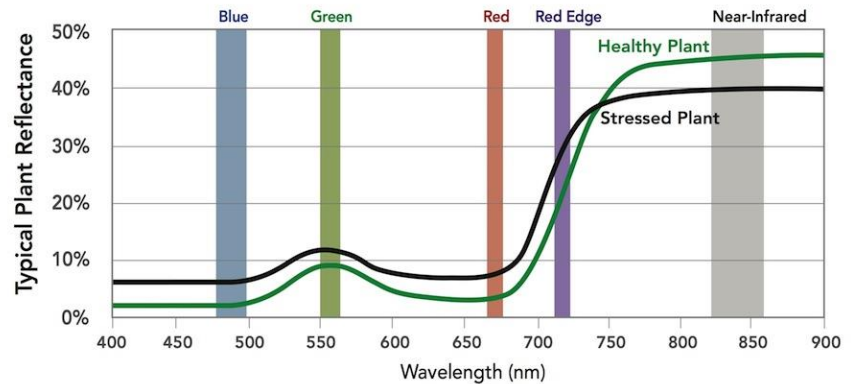
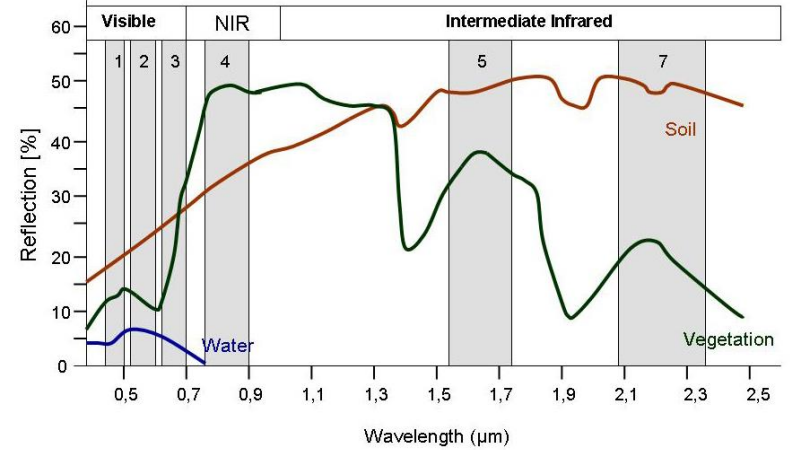
$$\frac{(0.50 - 0.08)}{(0.50 + 0.08)} = 0.72$$

$$\frac{(0.4 - 0.30)}{(0.4 + 0.30)} = 0.14$$

NDVI is calculated from the visible and near-infrared light reflected by vegetation. Healthy vegetation (left) absorbs most of the visible light that hits it, and reflects a large portion of the near-infrared light. Unhealthy or sparse vegetation (right) reflects more visible light and less near-infrared light. The numbers on the figure above are representative of actual values, but real vegetation is much more varied. (Illustration by Robert Simmon).

Source: earthobservatory.nasa.gov

Wavelength bands are designed to distinguish vegetation from bare soil and, with the “red edge” band, to distinguish healthy from unhealthy foliage.

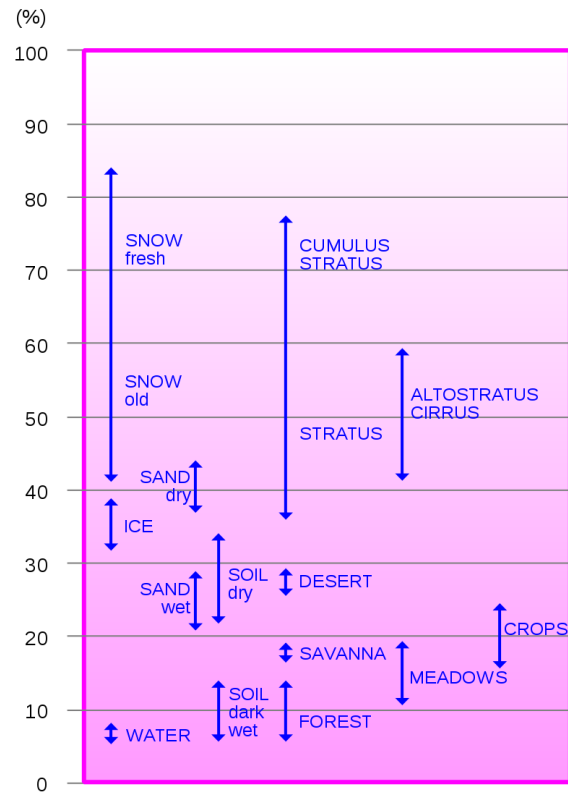


Visible Light → Non-Visible Light  
 Top: SEOS Project; Bottom: droneworks.org.nz

# Remote sensing of energy balance

## Land cover changes may entail large changes in albedo

Albedo is defined as the ratio of irradiance reflected to the solar irradiance received by a surface. Radiation that is not reflected is mostly re-radiated as heat and consumed to evaporate water (~1% is used in net primary production.)



Snow cover is most reflective.

Crops tend to be more reflective than forest.